NASA STTR 2017 Phase I Solicitation

T1.03 Real Time Launch Environment Modeling and Sensing Technologies

Lead Center: KSC

Participating Center(s): SSC

Technology Area: TA13 Ground and Launch Systems Processing

Launch and landing operations through the atmosphere of a planet are strongly affected by environmental and atmospheric conditions. Even the most robust vehicle design has physical limits that restricts the conditions through which it can be launched. Divergent fluid dynamics, lightning, and other severe conditions can overstress vehicle structures and cause a mishap. In addition, the safety of personnel performing launch preparations must be protected from extreme weather such as lightning in a manner that minimizes risk to the launch schedule. A key metric of launch architecture is the overall system's launch availability, which is in turn impacted by the accuracy with which the environmental conditions can be characterized. Advanced technologies are being solicited to improve the accuracy of launch and landing environment forecasting and evaluation. This technology is of interest not only for earth-based launches, but also to enable routine launch and landing activity on other planets such as Mars, where range infrastructure will be extremely limited. Specific areas of interest include the following:

Remote Sensing

During launch preparations, an acceptable launch environment that does not impart vehicle damage during ascent is critical. Currently, launch environment conditions such as wind direction, speed, temperature, humidity, and pressure are measured by launching several balloons with rawinsondes on launch day. The data is then used to construct a vertical profile initializing meteorological models that derive atmospheric stresses on a launch vehicle. Current technology is used for remote measurements of wind speed and direction as a function of altitude; however, there is no current capability to measure temperature and humidity as a function of altitude remotely in a cloudy environment. This capability needs to be satisfied by remote methods in order to improve accuracy by measuring overhead and improving timeliness by reducing the lag time to make the measurement and reducing the interval between measurements. In addition, a remote sensing approach would enable a lower cost simplified launch environment analysis with less infrastructure by eliminating the need for balloons and rawinsondes.

Technology is being sought which provides a remote sensing capability to measure thermodynamic data with respect to altitude from 300 meters to at least 10 km. The technology must have a vertical measurement resolution of 150 m or smaller and a full vertical profile of the thermodynamic data at least once an hour. The sensor must provide valid data in both cloudy and clear environments. Phase I should include a design for remote measurement of at least temperature and humidity as a function of altitude. Phase II should be prototype development, testing, and evaluation of the sensing technology in a subtropical environment as well as continued development to measure, or derive all three temperature, humidity, and pressure. Locally available rawinsonde data should be used to verify system accuracy.

Three-Dimensional Launch Window Modeling

During launch countdown, data from several disparate meteorological systems are used to evaluate environmental hazards such as triggered lightning during vehicle ascent. There are several rules based upon radar data, lightning location, electric field and the presence of clouds. For example, in certain circumstances, the launch vehicle cannot pass through a radar echo greater than 7.5 dBz. NASA is seeking a capability to simultaneously, and in real-time, visualize three-dimensional (3D) atmospheric data, and rocket/vehicle trajectories. The region in which a rocket/vehicle trajectory can safely travel through will be a 3D solid shape based upon the launch trajectory with allowable trajectory variations, and user-determined standoff distance. E.g., for a given rocket with trajectory variations of 4.5 miles and a safety standoff distance of 10 miles, a 3D shape such as a tube would be centered around the nominal trajectory line, and at all locations occupy the space 10 + 4.5 miles along the nominal trajectory. Atmospheric data will include: satellite, radar, and lightning data as well as meteorological model products (i.e., forecasts of radar data). The user must be able to manipulate the display to change orientation, scale and products/layers within the intersecting area.

At a minimum, the system should be able to identify areas where the trajectory shape intersect or enclose lightning data from 3D lighting data sources, and cloud data as identified by radar and a local Weather Research and Forecasting (WRF) model. Any data used for the technology or verification will be from the meteorological instrumentation used at KSC and owned by the USAF. Phase I would be development of requirements, proposed capabilities, and demonstration of sample products. Phase II would be development of application to ingest NASA and USAF meteorological data and products, and manipulate the data within the volume of interest.